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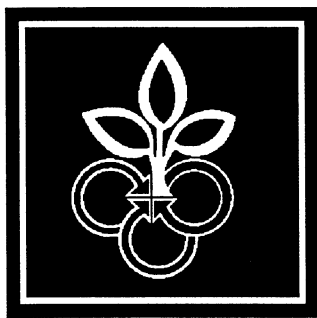
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PLANT · PATHOLOGY

PURDUE UNIVERSITY • WEST LAFAYETTE, IN

## Vegetable Diseases

Purdue University  
Cooperative Extension Service

# Identification and Control of Crucifer Diseases

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Broccoli, cabbage, cauliflower, and some other crucifer crops are grown commercially in almost all counties in Indiana. Among the most persistent constraints to their production are the infectious and non-infectious diseases that contribute to yield loss and a reduction in market quality. This bulletin addresses the major disease problems of crucifers in the Midwest and is intended to be used as an aid in their identification and management.

## Black Rot

Black rot of crucifers, caused by the bacterium *Xanthomonas campestris* pv *campestris*, is a destructive disease that attacks all cultivated types of crucifers. The plants can be affected at any stage of growth, although the most severe losses occur when seedlings are infected in plant beds where conditions are ideal for infection, rapid spread, and seedling death. Infections that occur in the field generally result in reduced yield and quality. Plants infected late in the season are less seriously affected than plants infected at an early growth stage.

**Symptoms.** The initial symptom of black rot infection is the presence of small, yellow-brown, V-shaped areas at the leaf margins. As lesions enlarge, the nearby veins turn black, and affected leaf issues dry out and turn brown. A cross-section of an infected stem cut near the soil surface will show a distinct ring of decayed tissue. Root systems on in-

fectured plants are less extensive than on healthy plants.

**Disease Cycle.** The black rot bacteria may survive in contaminated seed or in infested crop residue in Indiana fields. In the spring, the bacteria are spread to healthy plants and fields by splashing water, mechanical spread, insects, and handling infected plants. Black rot infection and spread is favored by wet weather and temperatures ranging from 80-86°F.

**Disease Control.** Obtaining disease-free seed and transplants is essential for control of black rot. It is also important to use clean, disinfested containers and planting materials. Crucifer plantings should be located where air and soil drainage are good. Cultural practices such as fall tillage hasten the decomposition of infested crop residue and will significantly reduce pathogen populations in fields of previously infected crucifer crops. Rotating fields out of crucifer crops for 3 years is advisable for both disease management and soil improvement. A small amount of late infection is tolerable; the idea is to take every possible precaution to delay infection until very late in the season. Spraying fields with fixed copper bactericides may help reduce the spread of the bacteria. Copper sprays will be most effective if conditions are not favorable for spread and pathogen populations are already low.

## Black Leg

Black leg, caused by the fungus *Phoma lingam*, occurs in all areas of

the temperate zones. In the past, black leg has been very destructive, but new effective controls have reduced the seriousness of the disease.

**Symptoms.** All parts of susceptible plants may be affected by black leg. The first symptoms are brown spots on leaves and stems that usually appear several weeks before transplanting. Once infected plants are established in the field, elongated, light brown, sunken areas with purplish margins form on stems near the soil line. These stem lesions expand in all directions and eventually girdle the entire stem and kill the plant. Light brown or grayish spots occasionally form on the leaves of the severely infected plants.

**Disease Cycle.** The black leg pathogen is capable of surviving in soil and crop debris in the Midwest for at least 3 years. The black leg pathogen also can be introduced into midwestern fields in and on the seed. The fungus becomes active in spring and produces spores on infested crop residue or on cotyledons of infected seedlings. The spores may be windblown or rain-splashed to other plants and fields.

**Disease Control.** Using disease-free seed and transplants from reputable sources is essential for black leg control. In fields with a history of black leg, a combination of cultural and chemical control practices can prevent serious losses. A 4-year rotation out of crucifers should be used because the pathogen may survive for several years in association with crop residue. Fall plowing will reduce the overwintering pathogen population, avoiding poorly drained fields will reduce the likelihood of infection.

A fungicide (Rovral®) is labeled for treatment of young plants in fields prone to black leg infection.

### Club Root

Club root, caused by the slime mold *Plasmodiophora brassicae*, was first recognized in Europe during the 13th century. It has since become the most serious disease of crucifer crops worldwide. Club root occasionally causes severe problems in isolated areas in Indiana fields. Most cruciferous weeds are susceptible and can serve as reservoirs of the pathogen from one year to another.

**Symptoms.** It is difficult to recognize the beginning signs of club root because the symptoms are mild. The above-ground symptoms of older club root infections include stunted and wilted tops, pale green and yellow leaves, and small heads. The common name of the disease is derived from the fact that roots may also enlarge to an unusual size. They often are spindle-shaped with thick centers and tapered ends, giving them a club-shaped appearance.

**Disease Cycle.** The club root pathogen enters plants through fine hairs on young roots or through wounds in the stem. As infection progresses, great masses of spores are formed within root tissues of enlarging roots. When infected tissue decays, the spores contaminate the soil. The club root pathogen is capable of surviving midwestern winters in the soil. Its introduction into new areas usually is associated with the movement of plants and soil.

**Disease Control.** Effective control of club root depends on preventing the pathogen from becoming established in the field. It is very important to grow or buy disease-free transplants. A 7-year rotation out of crucifers and an adjustment of field soil acidity to pH 7.2-7.5 are also helpful. It is

necessary to avoid contaminating clean fields with infested plants by not transferring soil or plants. In cases where crucifers must be planted into fields with a history of the disease, the use of PCNB (Terrachlor®) in transplant water may reduce disease incidence and severity. Control for seedbed plantings may be maintained by growing plants in a well-drained, uninfected area.

### Alternaria Leaf Spot

The *Alternaria* leaf spot, caused by the fungus *Alternaria brassicae*, affects almost all crucifers and has created serious problems on cabbage and cauliflower in Indiana. Losses occur mostly in the form of reduced market quality of heads, although in some cases the pathogen has attacked and killed young crucifer seedlings.

**Symptoms.** The *Alternaria* fungus produces round, brown lesions on infected leaves and oval or elongated lesions on stems. These lesions can enlarge to the size of a dime and are characterized by the presence of concentric rings within the dead tissue. Head infections result in much smaller "pin-point" brown or black lesions that ruin the appearance of cauliflower. Under storage conditions where temperatures are relatively high, the fungus may produce a brown mold on florets or wrapper leaves.

**Disease Cycle.** The source of initial disease each spring may be infected seed, transplants, or infested crop residue that overwinters in midwestern fields. In warm, wet conditions, lesions on infected plant material produce spores that may be windblown or rain-splashed to other plants or fields. The spores result in new infections that continue the cycle of lesion development,

spore production, dissemination, and infection. The fungus may survive in Indiana fields only in association with infected crop residue.

**Disease Control.** The first step towards effective control of Alternaria leaf spot involves using disease-free plant material and avoiding fields with a history of the disease. The disease can be controlled with repeated applications of protective fungicides. Genetic resistance to this disease is not available in commercial cultivars of major crucifer crops.

### Downy Mildew

Downy mildew, caused by the fungus *Peronospora parasitica*, is a serious disease that affects a wide range of crucifers, although it occurs sporadically in Indiana. Nearly all cultivated and weed species of the crucifer family are affected.

**Symptoms.** The initial symptom of downy mildew infection is the appearance of purplish, irregular spots on the leaves. During cool, moist conditions, the spots will enlarge and become yellow-brown in color. Cool, wet conditions also promote the development of a white mold between the veins on the undersides of leaves. As affected areas enlarge, they turn tan and papery. In severe cases, the whole leaf will die. Infected broccoli and cauliflower heads deteriorate rapidly and ruin the value of the head.

**Disease Cycle.** The disease cycle begins when young seedlings are infected by overwintering spores that germinate and penetrate young plants. The fungus colonizes the above-ground plant parts and produces spores on the lower surface of leaves. The spores may be rain-splashed or windblown to other

plants and fields. Spread of the pathogen occurs during temperatures of 50-60°F. Survival of the downy mildew fungus occurs via thick-walled spores which remain in the soil after the crop decays.

**Disease Control.** It is important to reduce pathogen populations with long (3-4 year) rotations since the fungus survives midwestern winters. Although downy mildew-tolerant varieties of some crucifers are available, control of this disease may depend on the application of protective and systemic fungicides during favorable environmental conditions.

### Fusarium Yellows

The Fusarium yellows disease, caused by the fungus *Fusarium oxysporum conglutinans*, threatened the entire cabbage industry in the early 1900's. Today Fusarium yellows is mainly a disease of susceptible cabbage and remains a serious problem in some midwestern radish production areas.

**Symptoms.** Symptoms of infection first occur within 2 to 4 weeks after transplanting. The entire plant appears to have a dull cast, and lower leaves turn yellow-green in color. The wilting of lower leaves may be more apparent on one side of the plant than the other. When stems of infected plants are cut in a cross section, internal necrosis (browning) usually is visible.

**Disease Cycle.** The Fusarium yellows fungus is capable of surviving many years in the soil, even in the absence of host plant debris. Infection is favored by warm soil temperatures (80-85°F) and does not develop well in temperatures below 61°F. The pathogen penetrates young root tissues after entering the plant through wounds or young rootlets. After reaching the water-conducting xylem tissues, it then progresses up the root and into stem,

effectively blocking water transport.

**Disease Control.** Because the pathogen may survive in midwestern soils, long rotations are not always effective in preventing Fusarium yellows in future crops. The best way to control the disease involves using yellows-resistant varieties and avoiding fields with a history of the disease.

### White Rust

White rust, caused by *Albugo candidans*, is a disease of crucifers that causes yield loss through defoliation, root injury, and reduction of market quality. Spinach, horseradish, and mustard are affected more seriously than other crucifers.

**Symptoms.** White rust produces small white pustules on the undersides of affected leaves. The pustules may enlarge and grow together to form larger, irregularly shaped lesions filled with the white spores. The upper surface of affected leaves shows a distinct mosaic pattern. Sometimes the disease results in club-like swellings on roots.

**Disease Cycle.** White rust is caused by a fungus that overwinters in midwestern soils as thick-walled, weather-resistant spores. The overwintering spores germinate in the spring and infect young seedlings. As disease development progresses, the pathogen produces other spores in pustules on the under surface of leaves. The spores may become airborne and spread to other plants and fields. Overwintering spores are produced in decaying crop debris and released into the soil.

**Disease Control.** The strategy for white rust control involves reducing the pathogen population in the field. This may be accomplished through procedures such as rotation out of cruciferous crops, fall plowing, and good weed control. Protective fungicides are available for use on only a few crops. White rust-resistant varieties are not available.

### **Boron Deficiency**

Boron deficiency is a nutritional disorder that occurs sporadically on broccoli grown in Indiana. The first symptom is a slight brown discoloration at some spot on the head. The brown spots can expand to cover the entire head and develop an odorous soft rot. A close internal inspection of the stem will show a cracked and brown or black cavity. A thorough soil test will identify boron deficient soils. Amending soils with boron in broadcast fertilizer will prevent boron deficiency.

### **Brown Bud**

Brown bud is a physiological disorder of broccoli that has been identified occasionally in Indiana over the past 5 years. Initial symptoms of brown bud include water soaking of individual florets within the head. The water soaking eventually results in a breakdown of tissues. This, in turn, results in rapidly progressing spot rot that ruins the value of the head. Not all cultivars are equally susceptible. The disorder is reported to be related to calcium nutrition during rapid growth phases.

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